The University of Chicago

ASYMMETRIC HYDRAZINE DERIVATIVES OF DIPHENYL

A DISSERTATION SUBMITTED TO THE FACULTY
OF THE DIVISION OF THE PHYSICAL SCIENCES
IN CANDIDACY FOR THE DEGREE OF DOCTOR
OF PHILOSOPHY

DEPARTMENT OF CHEMISTRY
1937

By
MELVIN ARTHUR GOLDBERG

Private Edition, Distributed by
THE UNIVERSITY OF CHICAGO LIBRARIES
CHICAGO, ILLINOIS
1940

The University of Chicago

ASYMMETRIC HYDRAZINE DERIVATIVES OF DIPHENYL

A DISSERTATION SUBMITTED TO THE FACULTY
OF THE DIVISION OF THE PHYSICAL SCIENCES
IN CANDIDACY FOR THE DEGREE OF DOCTOR
OF PHILOSOPHY

DEPARTMENT OF CHEMISTRY
1937

By
MELVIN ARTHUR GOLDBERG

Private Edition, Distributed by
THE UNIVERSITY OF CHICAGO LIBRARIES
CHICAGO, ILLINOIS
1940

R. UNIV.
BIBLIOTHEEK
LEIDEN

The author wishes to take this opportunity of expressing his gratitude for the invaluable aid and many helpful suggestions rendered by Dr. R. W. Johnson, under whose direction this work was done.

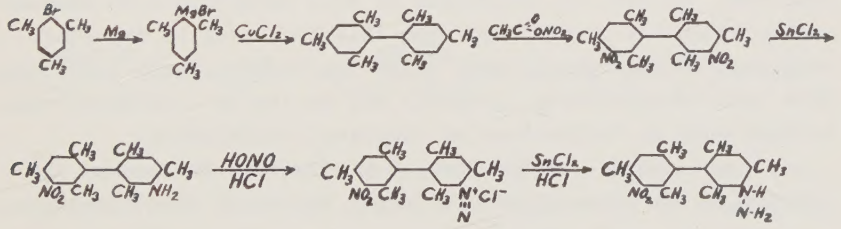
R. UNIV.
BIBLIOTHEEK
LEIDEN

INTRODUCTION

A considerable amount of work has been done in this laboratory on the study of the rates of hydrolysis of stereoisomeric oximes and hydrazones. Such studies are expected to cast light upon the mechanism of the hydrolysis of oximes and hydrazones. Obviously, if pairs of isomeric oximes or hydrazones were made using optically active reagents, it should be possible to follow the course of the hydrolyses by means of the polarimeter. Such a procedure would greatly expedite further research along these lines.

Hence, it was the purpose of this work to prepare and resolve, if possible, an optically active pair of hydrazines. Inasmuch as a great number of diphenyl derivatives have been resolved into isomers which display optical activity, it was decided to prepare a derivative of this type; that is, an optically active hydrazine derivative of diphenyl.

It was at first proposed to prepare a hydrazine derivative of dimesityl, since 3,3'-dinitro and 3,3'-diamino-dimesityl have been already prepared by Adams.[1] To this end, 3,3'-dinitro-dimesityl was prepared. It was intended to reduce one of the nitro groups of this compound, yielding 3-nitro-3'-amino-dimesityl. It should be possible to diazotize this compound and reduce the diazonium salt to a hydrazine:

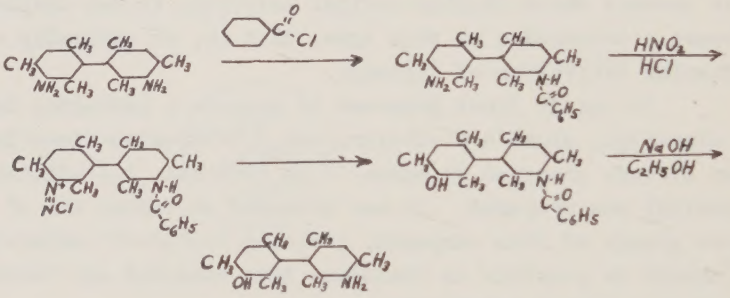


---

[1] W. W. Moyer and R. Adams, J. Am. Chem. Soc., 51, 630 (1929).

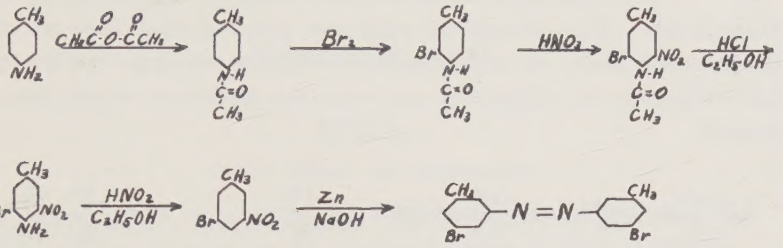
We were not able to reduce 3,3'-dinitro-dimesityl to 3-nitro-3'-amino-dimesityl in the usual manner by means of alcoholic ammonium sulfide. We were able to effect this reduction only by means of stannous chloride in alcohol-ether solution in the presence of hydrogen chloride. The yields in this reaction, however, were very unsatisfactory, making it impossible to obtain sufficient material for our purpose in this way.

Therefore, the 3,3'-dinitro-dimesityl was completely reduced by means of zinc in the presence of acid to 3,3'-diamino-dimesityl, in the hope of diazotizing one amino group of the latter. The diazonium salt thus formed could be reduced to the desired hydrazine derivative. Unfortunately, it was not possible to diazotize directly only one of the amino groups by any known method. However, by blocking one amino group of the 3,3'-diamino-dimesityl by means of benzoylation, 3-hydroxy-3'-amino-dimesityl was prepared by the following series of reactions:

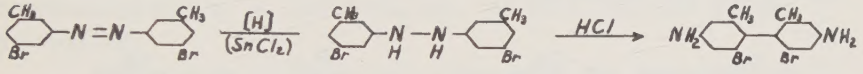


The 3-hydroxy-3'-amino-dimesityl so prepared was extremely unreactive. It gave no indication of salt formation with aqueous sodium hydroxide or with hydrogen chloride, even in dry ether. It could not be diazotized, even under the most vigorous conditions. This lack of reactivity, probably due to steric hindrance, made further work on derivatives of dimesityl inadvisable.

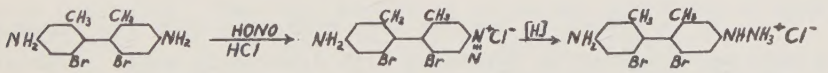
Afterwards, 3,3'-dibromo-5,5'-dimethyl-azobenzene was synthesized by means of the following series of reactions:



It was expected that treatment of the above azo-compound with acid in the presence of a reducing agent would result in the formation of 3,3'-dibromo-5,5'-dimethyl-hydrabenzene which, under these conditions, would immediately undergo a benzidine-like rearrangement. This rearrangement should yield 2,2'-dimethyl-6,6'-dibromo-4,4'-diamino-diphenyl:



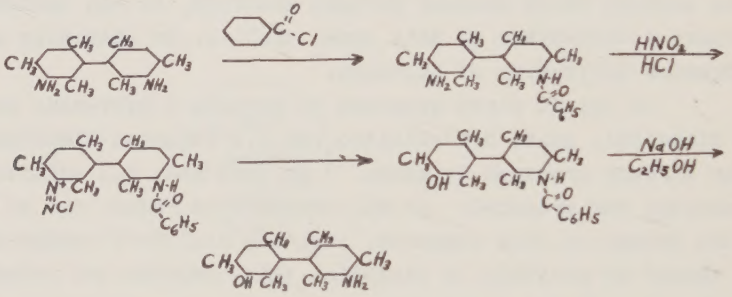
It is well known that benzidine can be readily diazotized to yield a <u>mono</u> diazonium salt. Since the above rearrangement product was proved to contain at least one primary amino group and should be a derivative of benzidine, an attempt was made to form the mono diazonium salt of this compound. By reduction of this diazonium salt it should be a simple matter to prepare 2,2'-dimethyl-6,6'-dibromo-4-amino-4'-hydrazino-diphenyl:



However, the methods ordinarily used to prepare the mono diazonium salt of benzidine failed when applied to our supposedly 2,2'-dimethyl-6,6'-dibromo-benzidine. Instead, the only product was apparently a diazoamino compound, a red-brown substance which defied hydrolysis even in the presence of concentrated acid. Hence, our rearrangement product may have been a derivative of semidine rather than a substituted benzidine. At any rate, if it was indeed a benzidine derivative, it had proved to be of no value for

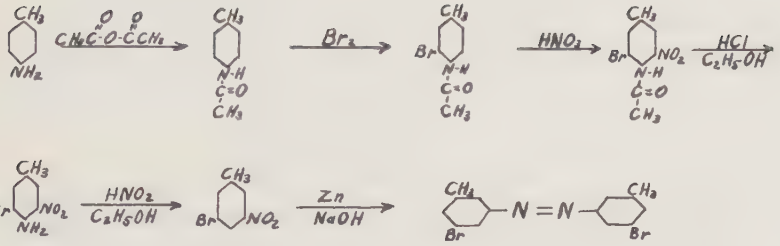
We were not able to reduce 3,3'-dinitro-dimesityl to 3-nitro-3'-amino-dimesityl in the usual manner by means of alcoholic ammonium sulfide. We were able to effect this reduction only by means of stannous chloride in alcohol-ether solution in the presence of hydrogen chloride. The yields in this reaction, however, were very unsatisfactory, making it impossible to obtain sufficient material for our purpose in this way.

Therefore, the 3,3'-dinitro-dimesityl was completely reduced by means of zinc in the presence of acid to 3,3'-diamino-dimesityl, in the hope of diazotizing one amino group of the latter. The diazonium salt thus formed could be reduced to the desired hydrazine derivative. Unfortunately, it was not possible to diazotize directly only one of the amino groups by any known method. However, by blocking one amino group of the 3,3'-diamino-dimesityl by means of benzoylation, 3-hydroxy-3'-amino-dimesityl was prepared by the following series of reactions:

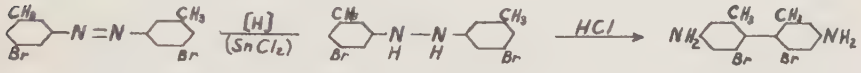


The 3-hydroxy-3'-amino-dimesityl so prepared was extremely unreactive. It gave no indication of salt formation with aqueous sodium hydroxide or with hydrogen chloride, even in dry ether. It could not be diazotized, even under the most vigorous conditions. This lack of reactivity, probably due to steric hindrance, made further work on derivatives of dimesityl inadvisable.

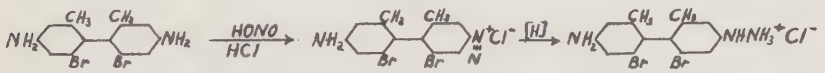
Afterwards, 3,3'-dibromo-5,5'-dimethyl-azobenzene was synthesized by means of the following series of reactions:



It was expected that treatment of the above azo-compound with acid in the presence of a reducing agent would result in the formation of 3,3'-dibromo-5,5'-dimethyl-hydrabenzene which, under these conditions, would immediately undergo a benzidine-like rearrangement. This rearrangement should yield 2,2'-dimethyl-6,6'-dibromo-4,4'-diamino-diphenyl:



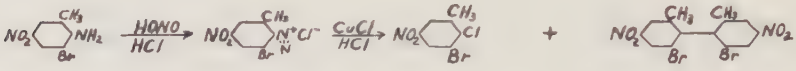
It is well known that benzidine can be readily diazotized to yield a mono diazonium salt. Since the above rearrangement product was proved to contain at least one primary amino group and should be a derivative of benzidine, an attempt was made to form the mono diazonium salt of this compound. By reduction of this diazonium salt it should be a simple matter to prepare 2,2'-dimethyl-6,6'-dibromo-4-amino-4'-hydrazino-diphenyl:



However, the methods ordinarily used to prepare the mono diazonium salt of benzidine failed when applied to our supposedly 2,2'-dimethyl-6,6'-dibromo-benzidine. Instead, the only product was apparently a diazoamino compound, a red-brown substance which defied hydrolysis even in the presence of concentrated acid. Hence, our rearrangement product may have been a derivative of semidine rather than a substituted benzidine. At any rate, if it was indeed a benzidine derivative, it had proved to be of no value for

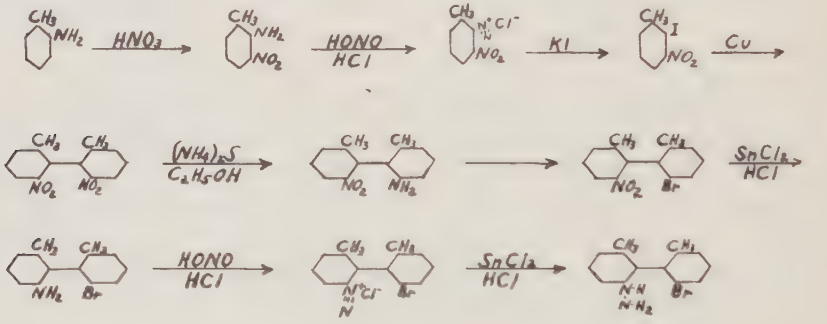
our purposes. Hence work along this line was abandoned.

Next 2-amino-3-bromo-5-nitro-toluene was prepared and diazotized. This diazonium salt was treated with cuprous chloride in the hope that, in addition to 2-chloro-3-bromo-5-nitro-toluene, 2,2'-dibromo-6-6'-dimethyl-4,4'-dinitro-diphenyl would also be formed:



Study of the reaction products showed, however, that only the 2-chloro-3-bromo-5-nitro-toluene was produced.

Finally, following the general method of Angeletti,[2, 3] 2-bromo-2'-amino-6,6'-dimethyl-diphenyl was prepared. This compound was diazotized, and the diazonium salt reduced to the corresponding hydrazine (XII). The reactions involved in this synthesis are the following:



In an effort to resolve this hydrazine into its isomers, a salt was prepared by treatment with d-tartaric acid. Crystallization yielded two distinct fractions of this product which were then decomposed in order to obtain the hydrazine itself. However, only a very small amount of material was available and decomposition made it impossible to isolate the free hydrazine.

---

[2] A. Angeletti, Gazz. Chim. Ital., 61, 651 (1931).

[3] Angeletti and Migliardi, ibid., 65, 819 (1935).

EXPERIMENTAL PART

Part I

Derivatives of Dimesityl

Preparation of mesitylene.--Mesitylene was prepared by the condensation of acetone by means of concentrated sulfuric acid according to the method of R. Adams and R. W. Hufferd.[4] The yield from 4600 grams of technical acetone was 387 grams of pure mesitylene, or 11.4 per cent of the theoretical.

Preparation of bromomesitylene.--Bromomesitylene was prepared from mesitylene by the action of bromine in carbon tetrachloride in the cold, according to the directions of L. Smith.[5] The yield from 193 grams of pure mesitylene was 276 grams of bromomesitylene, B. P. 106-7°/16 mm., or 93.5 per cent of the theoretical.

Preparation of dimesityl.--Dimesityl was prepared from bromomesitylene by way of mesityl magnesium bromide by the action of anhydrous cupric chloride according to the directions of R. Adams. The yield from 276 grams of bromomesitylene was twenty-eight grams of dimesityl, M. P. 99.5-100°, or 12 per cent of the theoretical.

Preparation of 3,3'-dinitrodimesityl.--(a) Preparation of acetyl nitrate: Nitrogen pentoxide was prepared according to the directions of Daniels[6] from nitric acid, which had been concentrated by repeated distillation over sulfuric acid, and phosphorus pentoxide. This was dissolved in acetic anhydride to give approximately a 50 per cent solution of acetyl nitrate.

(b) Preparation of 3,3'-dinitrodimesityl: Dimesityl was nitrated in carbon tetrachloride with acetyl nitrate according to the directions of R. Adams.[7] The yield from twenty-five grams

---

[4] Organic Syntheses, Coll. Vol. I, p. 334.

[5] Ibid., XI, 24.

[6] J. Am. Chem. Soc., 42, 1131 (1920).

[7] Moyer and Adams, op. cit.

of dimesityl was about thirty-two grams, 95 per cent of the theoretical, of crude dinitrodimesityl. Alternate recrystallizations from acetic acid and alcohol raised the melting point to 162.5-163.5° (corr.).

Reduction of 3,3'-dinitrodimesityl.--(a) Reduction with hydrogen sulfide: To a solution of 1 gram of dinitrodimesityl in 50 cc. of alcohol and 10 cc. of toluene, 1 cc. of concentrated ammonium hydroxide was added. A slow stream of hydrogen sulfide was passed into this cold solution for four hours, after which the solvent was evaporated. The solid recovered was the original dinitrodimesityl, M. P. 162°.

To a solution of 1 gram (0.0035 m.) of dinitrodimesityl in 30 cc. of alcohol and 10 cc. of toluene, 7 cc. of concentrated ammonium hydroxide was added. A slow stream of hydrogen sulfide was then passed into this solution at 45-50° until the weight increased by 0.35 gram, corresponding to 0.0103 m. of hydrogen sulfide. The solution was then refluxed for two and one-half hours and the solvent evaporated. The original dinitrodimesityl was recovered unchanged.

The above experiment was repeated at 75°, and again at the boiling point of the solution, with excess ammonium sulfide. The starting material was again recovered unchanged.

(b) Reduction with stannous chloride: A solution of dinitrodimesityl in dry ether was saturated with hydrogen chloride. To this solution was added a saturated solution of stannous chloride and hydrogen chloride in ether. The resulting solution was allowed to stand at room temperature for twenty-four hours, when a small amount of white solid separated. This substance had a melting point of about 155°. It was soluble in dilute hydrochloric acid and insoluble in aqueous alkali. Thus, it may have been an amine hydrochloride but the extremely minute amount of the substance obtained made it impossible to determine this with certainty.

To a solution of dinitrodimesityl in dry ether was added a saturated solution of stannous chloride in ether and the whole saturated with hydrogen chloride. The solution was refluxed for several hours over a small piece of tin and then allowed to stand overnight. The white solid which had precipitated was filtered off. The solid dissolved in dilute aqueous acid and was reprecipitated by sodium hydroxide. The alkaline mixture was extracted with ether, and the ether evaporated leaving a minute amount of a

yellow solid substance which melted at 143-4°. As will be shown below, this substance was 3-nitro-3'-aminodimesityl.

A solution of 0.215 g. (0.0065 m.) of dinitrodimesityl in alcohol was cooled in an ice bath. To this was added slowly, with stirring and cooling, a solution of 0.445 g. (0.02 m.) of stannous chloride in alcoholic hydrogen chloride. The alcohol was distilled off and the residue extracted with hot water containing a small amount of hydrochloric acid. Approximately 0.2 g. of solid material remained. This had a melting point of about 160° and undoubtedly consisted mainly of unreacted dinitrodimesityl. The dilute acid extract was treated with excess aqueous sodium hydroxide and yielded a very minute amount of solid material which melted above 210°. This material was, therefore, 3,3'-diamino-dimesityl (M. P. lit. 206-7°).

To a solution of 2.3 grams (0.007 m.) of dinitrodimesityl in 75 cc. of ether was added a solution of 5 grams (0.022 m.) of stannous chloride in 75 cc. of alcohol saturated with hydrogen chloride. The solution was refluxed for five hours, after which the solvent was evaporated. The residue was extracted with hot, very dilute hydrochloric acid and the resulting solution made strongly alkaline with sodium hydroxide. Extraction with ether yielded a solid which was recrystallized from a little dilute alcohol. The product consisted of about 0.15 grams of yellow needles, M. P. 143.5-144.5° (corr.). The yield was about 7 per cent of the theoretical of, as shown by analysis, 3-nitro-3'-amino-dimesityl.

Analysis (Micro Dumas N):

Calc. for $C_{18}H_{22}O_2N_2$ 9.45%

Found 9.78%

Attempts to reduce 3,3'-dinitrodimesityl to 3-nitro-3'-amino-dimesityl by means of stannous chloride, using dioxan as a solvent in an attempt to increase the yields, failed completely, the original dinitro compound being recovered unchanged.

3,3'-diaminodimesityl.--3,3'-diaminodimesityl was prepared in accordance with the directions of Adams[8] by reduction of 3,3'-dinitrodimesityl with zinc dust.

Diazotization of 3,3'-diaminodimesityl.--(a) An attempt was made to prepare the mono-diazonium salt of this compound by

---

[8] Ibid.

the method developed by Täuber[9] for benzidine. A solution of 0.117 g. (0.000437 m.) of 3,3'-diaminodimesityl in about 0.2 g. of concentrated hydrochloric acid and 1.2 g. of water was treated with 0.056 g. (0.000873 m.) of sodium nitrite in 0.64 cc. of water at 5° C., after which the solution was filtered and treated with 0.117 g. more of diaminodimesityl in dilute hydrochloric acid. This final solution was then allowed to stand for twenty-four hours at 10-20°, after which it was again filtered and an attempt was made to show the presence of a mono-diazonium salt. If such a compound were present, treatment with cuprous chloride should yield 3-amino-3'-chloro-dimesityl. The solution was therefore treated with excess cuprous chloride in hydrochloric acid. After heating on the steam bath for an hour, ammonium hydroxide in excess was added to dissolve copper compounds. The mixture was then filtered and the precipitate thoroughly washed with water. The product had a melting point of about 200°. A sodium fusion showed the presence of nitrogen, but no chlorine. The product consisted, therefore, only of unreacted diaminodimesityl. Hence the mono diazonium salt of 3,3'-diaminodimesityl had not been obtained.

A modification of this method in which the entire quantity of 3,3'-diaminodimesityl was dissolved in hydrochloric acid and treated directly with only one mole of sodium nitrite, and then immediately with cuprous chloride, apparently gave a mixture of products. From the reaction products, approximately one-half of the original quantity of diaminodimesityl was extracted by dilute aqueous hydrogen chloride. Because of the small amount of material used (0.1 g.), it was impossible to isolate other products.

Benzoylation of 3,3'-diaminodimesityl.[10]--To a solution of 0.5 g. (0.00186 m.) of diaminodimesityl in 10-12 cc. of toluene 0.25 g. (0.0018 m.) of benzoyl chloride was added slowly with shaking. A white precipitate formed immediately, whereupon the mixture was warmed for a few minutes and then filtered.

A solution of the product in dilute alcohol gave a precipitate of silver chloride with silver nitrate. The product was therefore the hydrochloride of 3-amino-3'-benzoylamino-dimesityl. On standing in air, the substance lost hydrogen chloride, turning

---

[9] Ber., 27, 2627 (1894).

[10] Frdl., 3, 24.

meanwhile, to an oil which subsequently solidified but no longer gave a precipitate with silver nitrate.

Neutral equivalent of the above hydrochloride:

0.2659 g. required 8.70 cc. of 0.0727 N NaOH

M. W. 420

Calc. for $C_{25}H_{29}ON_2Cl$ 405

Preparation of 3-iodo-3'-benzoylamino-dimesityl.--To a solution of 0.025 g. of 3,3'-diaminodimesityl in pyridine 0.1 cc. of benzoyl chloride was added. After a short time, water was added to precipitate the 3-amino-3'-benzoylamino-dimesityl. Two recrystallizations from dilute alcohol gave a white product which melted at 173° with previous softening.

The benzoylated product was diazotized in 50 per cent acetic acid, and the diazonium salt poured into a concentrated aqueous solution. After standing overnight, the mixture was filtered and the precipitate washed with water, with a solution of sodium thiosulfate, and finally with water. The product melted below 140° but over a wide range, even after repeated recrystallizations from dilute alcohol.

Analysis (Micro Dumas N):

Found 2.59%

Calc. for $C_{25}H_{26}ONI$ 2.90%

Hence it seemed probable that the product was impure 3-iodo-3'-benzoylamino-dimesityl.

Hydrolysis of the supposed 3-iodo-3'-benzoylamino-dimesityl.--The compound prepared in the above reaction was refluxed with a mixture of glacial acetic acid and concentrated hydrochloric acid (1:1) for two hours. Water was then added, the precipitate filtered off and recrystallized from dilute alcohol. The product had a melting point of 171-172.5°. A sodium fusion showed the presence of iodine. Attempts to diazotize the product, however, failed, and a nitrogen analysis found only 1.1% N (Calc. for the supposed 3-iodo-3'-amino-dimesityl. . . . 3.7%).

Preparation of 3-hydroxy-3'-amino-dimesityl.--A solution of about 0.2 g. of 3-amino-3'-benzoylamino-dimesityl in 50 per cent acetic acid was diazotized with a concentrated solution of sodium nitrite. The diazonium solution was diluted with an equal volume of dilute hydrochloric acid and heated to boiling. The mixture was allowed to cool, and the product filtered. The solid was then refluxed with a solution of sodium hydroxide in 50 per

cent alcohol for one-half hour, then diluted with water and allowed to cool. The product, crystallized from dilute alcohol, melted at 238°.

Analysis (Micro Dumas N):

Found 5.23%

Calc. for $C_{18}H_{23}ON$ 5.20%

The 3-hydroxy-3'-amino-dimesityl was insoluble in aqueous sodium hydroxide and in hydrochloric acid. No hydrochloride was precipitated in dry ether solution by dry hydrogen chloride. Attempts to diazotize the compound, even in concentrated sulfuric acid by means of nitrosylsulfuric acid[11,12,13] proved futile.

Part II

Dibromo-dimethyl-diphenyls

Preparation of 3-bromo-4-acetylamino-toluene.--3-bromo-4-acetylamino-toluene was prepared from 535 g. of commercial para-toluidine according to the directions of J. R. Johnson and L. T. Sandborn.[14] The yield was 730 g. of almost colorless needles, or 69 per cent of the theoretical. M. P. 116-117°.

Preparation of 3-bromo-5-nitro-4-acetylamino-toluene.--3-bromo-5-nitro-4-acetylamino-toluene was prepared by nitration of 640 g. of 3-bromo-4-acetylamino-toluene with 750 cc. of fuming nitric acid and 450 cc. of concentrated nitric acid at 35-40°. The nitro product was recovered by pouring the reaction mixture into a large quantity of water. The precipitate was recrystallized first from glacial acetic acid, then from 95 per cent alcohol. Yield 400 g. or 52 per cent of the theoretical. M. P. 210.5°.

Hydrolysis of 3-bromo-5-nitro-4-acetylamino-toluene.--A mixture of 390 g. of the brom-nitro-acetylamino-toluene, 1500 cc. of concentrated hydrochloric acid, and 250 cc. of 95 per cent alcohol was refluxed for about five hours. About one liter of water was then added and the mixture allowed to cool. The solidi-

---

[11] Misslin, Helv. Chim. Acta, 3, 626 (1920).

[12] Schoutissen, J. Am. Chem. Soc., 55, 4531 (1933).

[13] Schoutissen, J. Chem. Soc., 1620 (1933).

[14] Organic Syntheses, VI, 8.

fied brom-nitro-amino-toluene was then filtered and washed with water. The yield after drying at this point was 325 g., a practically theoretical yield. The product melted at 62-64° and was used directly.

Deamination of 3-bromo-5-nitro-4-amino-toluene.[15]--In a 5-liter flask equipped with a reflux condenser and a wide tube closed with a cork was placed a solution of 300 g. (1.3 m.) of the 3-bromo-5-nitro-4-amino-toluene in 2200 cc. of 95 per cent alcohol. One hundred eighty cc. of concentrated sulfuric acid was added and then, as rapidly as the heat of the reaction permitted, 180 g. (2.6 m.) of sodium nitrite. After the reaction subsided, the mixture was refluxed for one hour. It was then made alkaline with sodium hydroxide, and steam distilled. The yellow solid which came over was isolated and distilled at 10 mm. pressure. B. P. 132-134°. The distilled product was then recrystallized twice from alcohol. Yield, 180 g. or 64 per cent of the theoretical. M. P. 83.5-84.2° (corr.).

Analysis (Micro Dumas N):

Found 6.47%

Calc. for $C_7H_6O_2NBr$ 6.48%

Preparation of 3,3'-dibrom-5,5'-dimethyl-azobenzene: To a solution of 25 g. of 3-brom-5-nitro-toluene in 125 cc. of hot alcohol, was added 16 g. of zinc dust, and then 40 cc. of a 30 per cent aqueous solution of sodium hydroxide was added under reflux as fast as the heat of the reaction permitted. Refluxing was continued for one hour, after which the product was precipitated by the addition of water. The precipitate was filtered and dried, after which the azo compound was extracted from the excess zinc by means of ether in a continuous extractor. The ether was evaporated and the residue recrystallized from 95 per cent alcohol. The yield was 13 g. or 61 per cent of the theoretical of orange needles. M. P. 164.5-165° (corr.).

Analysis (Micro Dumas N):

Found 7.56%

Calc. for $C_{14}H_{12}N_2Br_2$ 7.61%

Reduction and rearrangement of 3,3'-dibrom-5,5'-dimethyl-

---

[15] G. H. Coleman and W. F. Talbot, ibid., XIII, 96.

azobenzene.[16,17]--To a solution of 25 g. of the azo compound in 500 cc. of hot alcohol a solution of 30 g. of stannous chloride in 200 cc. of concentrated hydrochloric acid was added slowly with constant stirring. The solution was then warmed (60-70°) for two hours, after which it was cooled and diluted to about one liter with water and saturated with hydrogen sulfide. The precipitated tin sulfides were removed by filtration, the filtrate was made alkaline with ammonium hydroxide and extracted with ether. The ether extract was dried over a little potassium carbonate and the ether distilled, leaving a gummy residue. This residue was taken up in a small quantity of xylene, warmed to about 40° and ligroin (B. P. 40-50°) added until crystallization set in. The solution was then allowed to cool slowly and the crystals filtered with suction. After drying thoroughly on a porous plate, the product was recrystallized from dilute alcohol. Yield about 10 g. of brilliant white needles (about 40 per cent of the theoretical). M. P. 150.5-151° (corr.).

This compound is soluble in hydrochloric acid, yielding a solution from which it can be reprecipitated by alkali. Diazotization followed by coupling with beta-naphthol proves the presence of at least one primary amino group.

Analysis (Micro Dumas N):

Found 7.47%

Calc. for $C_{14}H_{14}N_2Br_2$ 7.57%

Diazotization of the rearrangement product.--On the assumption that the compound prepared above was a benzidine derivative (2,2'-dibrom-6,6'-dimethyl-benzidine) an attempt was made to diazotize one of the amino groups by the method found in D. R. P. 51,576.[18] To a solution of 1 g. (0.0027 m.) of the rearrangement product in 0.2 cc. of glacial acetic acid, 0.8 cc. of concentrated hydrochloric acid, and 10 cc. of water, a solution of 0.19 g. (0.0027 m.) of sodium nitrite in 0.5 cc. of water was added slowly with stirring and cooling (0-5°). This procedure caused the precipitation of a red-brown substance corresponding to the diazoamino compound produced in the diazotization of benzidine under these conditions.[19]

---

[16]Schmidt and Schultz, Ann., 207, 330 (1881).

[17]Schultz, Ber., 17, 467 (1884).

[18]Frdl., 2, 469, 470. [19]Ibid.

The mixture so produced was then allowed to stand in an ice bath after the addition of 2 cc. of concentrated hydrochloric acid. No change was noticed during this period. The reaction mixture was then removed from the ice bath and allowed to stand at room temperature for eighteen hours. When, at the end of this time, still no change was observed, 5 cc. of concentrated hydrochloric acid were added. However, even this caused no apparent reaction over a period of several days at room temperature.

Attempt to prepare 2,2'-dibrom-6,6'-dimethyl-4,4'-diiodo-diphenyl.--In an attempt to prove the structure of the supposed 2,2'-dibrom-6,6'-dimethyl-benzidine, 1 g. of the rearrangement product was dissolved in 2.5 cc. of hydrochloric acid and 6.5 cc. of water, and completely diazotized by the addition of 0.38 g. of sodium nitrite in 2.5 cc. of water. The addition of about one-half of the sodium nitrite resulted in the precipitation of considerable quantities of an orange colored substance which was completely dissolved by the addition of the remaining nitrite solution. The resulting diazonium solution was then poured into a cold concentrated aqueous solution of potassium iodide and allowed to stand overnight. The precipitate was then isolated, washed with water, then with a solution of sodium thiosulfate, then with water. The residue was dried, dissolved in chloroform, and reprecipitated with alcohol. The product was an orange colored solid melting over a range of several degrees at about 150°. A nitrogen analysis showed the presence of 1.19% N although the desired compound should contain no nitrogen.

The nature of the products of these reactions being unsatisfactory and indefinite, it was not thought wise to continue their study further.

Part III

Other Compounds

2-bromo-2'-hydrazino-6,6'-dimethyl-diphenyl

Preparation of 2-amino-3-nitro- and 2-amino-5-nitro-toluene.-- O-acetotoluide was prepared by the action of acetic anhydride on 71.4 g. (0.7 m.) of o-toluidine.[20,21] The yield was

---

[20] F. Beilstein and A. Kuhlberg, Ann., 156, 72 (1870).

[21] A. Kaufmann, Ber., 42, 3481 (1909).

87 g. or 83.6 per cent of the theoretical. The o-acetotoluide was nitrated according to the directions of Cohen and Dakin.[22] The yield was 30 g. of 2-amino-3-nitro-toluene M. P. 97° and 24 g. of 2-amino-5-nitro-toluene M.P. 132-3°. This corresponds to an overall yield of 60 per cent of the theoretical.

Preparation of 2-amino-3-bromo-5-nitro-toluene.--A solution of 10 g. of 2-amino-5-nitro-toluene in 150 cc. of glacial acetic acid was brominated by the addition of 11.1 g. of bromine with mechanical stirring. The solution was stirred for an hour after the bromine had been added and was then poured into 250 cc. of water. The crystalline sludge was then stirred for a few minutes and allowed to stand overnight. Finally, 200 cc. of water was added and the precipitate separated by filtration. Recrystallization from alcohol yielded yellow needles, M. P. 184-5-185° (corr.). The yield was 12 g. or 80 per cent of the theoretical.

An attempt to prepare 2,2'-dibrom-6,6'-dimethyl-4,4'-dinitro-diphenyl.[23,24]--A solution of 13 g. of 2-amino-3-bromo-5-nitro-toluene in 20 cc. of concentrated sulfuric acid was poured onto about 50 g. of crushed ice. The resulting suspension was diazotized with a solution of 3.6 g. of sodium nitrite in 15 cc. of water. After standing for one-half hour, the diazonium solution was filtered. A cold solution of 6 g. of cuprous chloride in about 40 cc. of concentrated hydrochloric acid was then run in slowly with vigorous mechanical stirring. The mixture was allowed to warm up to room temperature with continued stirring. It was then filtered, and the precipitate extracted with ether. The ether was distilled and the residue steam distilled. A white solid came over in the steam. This was recrystallized from alcohol after which it melted at 98-99° (corr.).

Analysis (Micro Dumas N):

Found 5.51%

Calc. for $C_7H_5O_2NBrCl$ 5.60%

This compound was therefore 2-chlor-3-brom-5-nitro-toluene and not the desired compound. No appreciable residue was obtained from the steam distillation; hence, none of the desired diphenyl

---

[22] J. Chem. Soc., 79, 1127 (1901).

[23] Ullman and Forgan, Ber., 34, 3802 (1901).

[24] Niementowski, ibid., p. 3325.

derivative was formed in the reaction.

Preparation of 2-iodo-3-nitro-toluene.--2-iodo-3-nitro-toluene was prepared from 27.5 g. of 2-amino-3-nitro-toluene by diazotization and treatment of the diazonium salt with potassium iodide according to the directions of Wheeler and Liddle.[25] The yield was 40.5 g. or 85 per cent of the theoretical. M. P. 67-68°.

Preparation of 2,2'-dinitro-6,6'-dimethyl-diphenyl.--2,2'-dinitro-6,6'-dimethyl-diphenyl was prepared by means of the Ullmann[26,27] reaction. In a test tube placed in an oil bath, 16 g. of iodo-nitro-toluene were melted and heated to 220°. To the melt 12 g. of copper bronze were added during constant stirring with a thermometer at such a rate that the temperature remained between 230° and 240°. After all the copper had been added, the mass was heated to 250° for about fifteen minutes. The reaction mixture was then allowed to cool and the product extracted from the mass with hot benzene in successive small portions. The benzene extracts were combined, evaporated to dryness. The residue was recrystallized from alcohol. Yield 6.2 g. of almost colorless crystals (75 per cent of the theoretical). M. P. 109-110°.

Preparation of 2-nitro-2'-amino-6,6'-dimethyl-diphenyl.--2,2'-dinitro-6,6'-dimethyl-diphenyl was reduced by means of ammonium sulfide according to the directions of Angeletti.[28] It was noted, however, that the presence of considerable excess of ammonium hydroxide improves the yield of the amino-nitro-ditolyl. The overall yield from several successive reductions, starting with 12 g. of 2,2'-dinitro-6,6'-dimethyl-diphenyl, was 7.5 g. of 2-amino-2'-nitro-6,6'-dimethyl-diphenyl. Two g. of unchanged dinitro-ditolyl was recovered. The M. P. of the 2-amino-2'-nitro-6,6'-dimethyl-diphenyl was 122-123°.

Preparation of 2-nitro-2'-bromo-6,6'-dimethyl-diphenyl.--2-nitro-2'-bromo-6,6'-dimethyl-diphenyl was prepared from 2-nitro-2'-amino-6,6'-dimethyl-diphenyl by means of the Sandmeyer reaction

---

[25] Am. Chem. J., 42, 451 (1909).

[26] Ullmann and Bielecki, Ber., 34, 2177 (1901).

[27] Ullmann and Frentzel, ibid., 38, 727 (1905).

[28] Gazz. Chim. Ital., 61, 651 (1931).

according to the directions of Angeletti.[29,30] The product was found to crystallize much more readily from glacial acetic acid, however, than from the ligroin recommended. The yield from 6 g. of amino-2'-nitro-6,6'-dimethyl-diphenyl was 2.5 g. or 33 per cent of the theoretical. M. P. 122-123° (corr.).

Preparation of 2-bromo-2'-amino-6,6'-dimethyl-diphenyl.--2-bromo-2'-nitro-6,6'-dimethyl-diphenyl was reduced with stannous chloride according to the method of Angeletti.[31] The yield from 2 g. of 2-bromo-2'-nitro-6,6'-dimethyl-diphenyl was 1.7 g. or 94.4 per cent of the theoretical. The melting point, however, was 86-87° (corr.) whereas Angeletti[32] reports 77-78°. It is perhaps significant that Angeletti, in the same article, reports the melting point of 2-chloro-2'-amino-6,6'-dimethyl-diphenyl as 87-88°.

Analysis (Micro Dumas N):

Found 5.02, 5.09%

Calc. for $C_{14}H_{14}NBr$ 5.07%

Preparation of 2-bromo-2'-hydrazino-6,6'-dimethyl-diphenyl.--2-bromo-2'-hydrazino-6,6'-dimethyl-diphenyl was prepared by the method of V. Meyer.[33] A suspension of 1.5 g. (0.00543 m.) of 2-bromo-2'-amino-6,6'-dimethyl-diphenyl in 12 cc. of concentrated hydrochloric acid was heated to boiling and then cooled in ice. To this mixture, a cold solution of 0.4 g. (0.0058 m.) of sodium nitrite in 3 cc. of water was added gradually with shaking over a period of about forty-five minutes. The diazonium solution was then filtered from the small amount of undissolved material and treated with a cold solution of 2.5 g. of stannous chloride in 2.5 cc. of concentrated hydrochloric acid. The reaction mixture was then allowed to stand in an ice bath for one hour, after which the precipitate was isolated by filtering rapidly and washing with a very small amount of ice water. The product was placed in a separatory funnel, treated with a solution of sodium carbonate (excess), and extracted with ether. The

---

[29] Ibid., p. 831.

[30] Angeletti and Migliardi, op. cit. [31] Ibid.

[32] Gazz. Chim. Ital., 61, 831 (1931).

[33] V. Meyer and M. T. Lecco, Ber., 16, 2976 (1883).

ether was filtered from precipitated basic tin compounds, dried over anhydrous potassium carbonate, and the ether evaporated by means of suction in a vacuum desiccator. The residue was recrystallized from 40-50° ligroin.

About 0.65 g. of white crystals were obtained (41 per cent of the theoretical). The product darkens very rapidly, becoming pale orange almost instantly, and readily decomposing completely to a reddish gummy substance. M. P. 119-120° (corr.).

Analysis (Micro Dumas N):

Found 9.72%, 9.78%

Calc. for $C_{14}H_{15}N_2Br$ 9.62%

Attempt to resolve 2-bromo-2'-hydrazino-6,6'-dimethyl-diphenyl.--To a solution of 0.5 g. (0.0017 m.) of 2-bromo-2'-hydrazino-6,6'-dimethyl-diphenyl in 2.5 cc. of hot absolute alcohol was added a solution of 0.27 g. (0.0018 m.) of d-tartaric acid in 2.5 cc. of hot absolute alcohol. About 0.4 g. of a white crystalline substance separated on cooling. This substance, presumably the d-tartrate of either the d- or l-form of the hydrazine, was isolated by filtration and recrystallized from absolute alcohol. After two recrystallizations, it melted at 152-155° (corr.) with decomposition.

Concentration of the mother liquor from the separation of the above tartrate, yielded a yellow syrup, presumably the other isomer of the hydrazine salt.

Decomposition of the tartrates by means of hydrochloric acid followed by the addition of ammonium hydroxide, unfortunately failed to produce anything but tar, since the unstable hydrazine had undergone too great decomposition. Hence, it was impossible to show a separation into two isomers, and the small amount of material available did not permit of further investigation.

SUMMARY

(1) 3-hydroxy-3'-amino-dimesityl has been prepared and its properties studied.

(2) The remarkable inertness of 3-hydroxy-3'-amino-dimesityl is noteworthy. This compound was found to form no salt with aqueous sodium hydroxide or with hydrogen chloride, even in dry ether. It proved completely indifferent towards nitrous acid under the most vigorous conditions.

(3) 3,3'-dibromo-5,5'-dimethyl-azobenzene has been prepared and studied.

(4) 3,3'-dibromo-5,5'-dimethyl-azobenzene has been found to undergo a benzidine-like rearrangement under the influence of hydrochloric acid in the presence of stannous chloride. This reaction undoubtedly proceeds by way of 3,3'-dibromo-5,5'-dimethyl-hydrazobenzene.

(5) It has been shown that treatment of the diazonium salt of 2-amino-3-bromo-5-nitro-toluene with cuprous chloride produces no 2,2'-dibromo-6,6'-dimethyl-4,4'-dinitro-diphenyl, but only the normal product, 2-chloro-3-bromo-5-nitro-toluene.

(6) 2-bromo-2'-hydrazino-6,6'-dimethyl-diphenyl has been prepared. This compound was not resolved into antipodes; the small amount of material available restricted the investigation.

(7) The melting point of 2-bromo-2'-amino-6,6'-dimethyl-diphenyl has been found to be 86-87° (corr.) instead of 77-78° as reported by Angeletti.